



Commonwealth Edison

One First National Plaza, Chicago, Illinois

Address Reply to: Post Office Box 767

Chicago, Illinois 60690

DMB

September 10, 1982

Mr. Darrell G. Eisenhut, Director
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Zion Station Units 1 and 2
I.E. Bulletin 80-11, Masonry Walls
NRC Docket Nos. 50-295 and 50-304

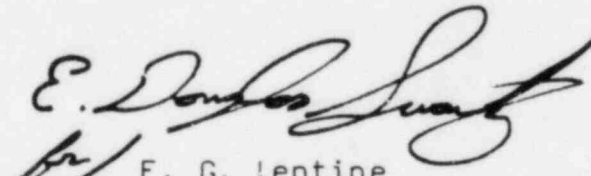
Reference (a): July 12, 1982, letter from
S. A. Varga to L. O. DelGeorge.

Dear Mr. Eisenhut:

In response to NRC's request of reference (a), this is to provide additional information regarding masonry walls at Zion Station. The Attachment to this letter provides the information requested.

Please address questions regarding this matter to this office.

Very truly yours,


F. G. Lentine
Nuclear Licensing Administrator

lm

Attachment

cc: J. G. Keppler
D. L. Wigginton
Region III Inspector - Zion

4973N

SEP 14 1982

8209210233 Q

1E11

ATTACHMENT

COMMONWEALTH EDISON COMPANY

ZION STATION UNITS 1 and 2

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
ON
MASONRY WALLS

1. The SEB Criteria (8) indicate that for operating plants the load combinations provided in the plant FSAR should be used in re-evaluation of masonry walls. Explain and justify the difference (if any) between the load combinations provided in the plant FSAR and the load combinations given in Table 5-1 of Reference 1.

Response

As pointed out in Section 5 of Reference 1, Masonry Walls at Zion are not subjected to loads such as wind, tornado, tornado missile, thermal loads, loads generated by a postulated pipe break, and loads due to pressure differential. Therefore, the combinations in Table 5-1 of Reference 1 are consistent with those provided in the Zion FSAR Volumes 2 and 8.

2. Provide the boundary conditions and modeling techniques used in the re-evaluation of masonry walls at Zion plant.

Response

The Boundary conditions and modeling techniques used in the re-evaluation of masonry walls at Zion are discussed in Section 6.0 of Reference 1.

3. Indicate how earthquake forces in three directions were considered in the seismic analysis of masonry walls.

Response

The Masonry Walls at Zion Units 1 and 2 are non-load bearing, interior partition walls which are not part of the shear wall system. All concrete masonry walls have been designed for out-of-plane seismic loadings. Vertical seismic acceleration is less than 1.0g for all these walls, thus causing no net tension on the walls. In-plane inertial loads have also been considered in the design for each wall.

In accordance with the Zion FSAR, one horizontal earthquake component is combined with the vertical component. Any effects of combined horizontal and vertical excitation were summed using SRSS techniques.

4. Provide the number of unreinforced walls and a sample calculation illustrating the analytical approach used for single-wythe and multiple-wythe wall.

Response

There are a total of 130 safety-related walls at Zion, 100 of which are single-wythe construction. Of these, 86 walls are unreinforced. A sample calculation illustrating the analytical approach is attached for your reference.

5. With reference to Section 4.1 of Reference 1, justify the increase factor of 1.67 applied to allowable stresses for abnormal/extreme environmental loading combinations involving DBE. The SEB criteria (5) allow increase factors of 1.5 for tension parallel to the bed joint and shear in the reinforcement, and 1.3 for tension normal to bed joint and masonry shear. If the Licensee intends to use any existing test data to justify this increase factor, the Licensee is required to discuss the applicability of these tests to the masonry walls at the plant with particular emphasis on the following areas: boundary condition, type of load, size of walls, and type of masonry construction (block type, grouted, or ungrouted).

Response

The Zion plant masonry wall criteria in Reference 1 were established prior to the existence of the SEB criteria. Table A (attached) provides a comparison of the Zion and SEB interim criteria allowable stresses for unreinforced concrete masonry design.

A survey of all safety-related walls subjected to out-of-plane loads indicates the 100% of the horizontally spanning walls fall within the SEB allowable stresses. Tension perpendicular to the bed joint is neglected for these walls. Vertically spanning walls incorporate vertical reinforcement to carry the tension perpendicular to the bed joint.

For in-plane loading, shear stresses under SSE load combinations for all walls except one fall within the SEB allowable stress of 43 psi. The remaining wall is stressed to 44 psi which is within 3% of the SEB allowable and, therefore, acceptable. Tension perpendicular to the bed joint was neglected for overturning and stability calculations.

6. Provide sample calculations to indicate how the effects of higher modes of vibration are accounted for in the masonry wall analysis.

Response

A sample calculation has been provided in the response to question number 4. As illustrated in that calculation a 1.05 amplification factor is used to account for the participation of higher order modes of vibration.

The 1.05 factor is based on a parametric finite element study to determine the effect of the participation of higher modes. The walls were modelled as plate elements and were subject to a uniform lg response spectrum. The study bounded all wall aspect ratios, boundary conditions and openings typical at the Zion station. When considering the first eight modes of vibration it was determined that 99% of the response was from the 1st mode. The 1.05 factor is an upper bound and is, therefore, adequate to include the effect of higher modes for concrete masonry walls at Zion.

7. Indicate the mode of failure of each wall not qualified under the working condition. Provide details of proposed modifications for each wall with sketches and demonstrate through sample calculations that the wall will be qualified after modification.

Response

The information regarding walls originally found to be not qualified is on file with our Architect Engineers and is available for your review at their offices. A sample calculation has been included in response to Question Number 4.

8. Provide a status report for the proposed modifications to the walls that do not meet the acceptance criteria described in Reference 4.

Response

The masonry wall modifications and their completion schedule have been reviewed and approved by the NRC Region III (Reference 2).

As of this date, all modifications but one have been completed. One nonconforming wall remains in an office area that is presently undergoing modification to house computer equipment for support of our Emergency Response Facilities. Completion of the modifications of that wall is tied to the completion of the computer modifications, which is presently scheduled for December 31, 1982.

REFERENCES

1. November 6, 1980, letter from J. S. Abel to J. G. Keppler, transmitting 180-day response to I.E. Bulletin 80-11.
2. March 2, 1982, letter from C. E. Norelius to Cordell Reed transmitting I.E. Inspection Report Nos. 50-295/82-06 and 50-304/82-06/

TABLE A

COMPARISON OF ALLOWABLE STRESSES IN PSI (INSPECTED WORKMANSHIP)
FOR UNREINFORCED CONCRETE MASONRY DESIGN

TYPE N MORTAR $f_m' = 900$ psi $M_o = 750$ psi

No.	Stress	Type of Masonry Unit	SSE Load Combinations	
			(a) Criteria Used on Zion	(b) SEB Interim Criteria Rev. 1
1.	Tension Perpendicular to Bed Joints F_{t1}	H	19	17
		S&G	36	35
2.	Tension Parallel to Bed Joints F_{t11}	H	45	41
		S&G	69	62
3.	Shear	H	50	43
		S&G	50	43
4.	Flexure Compressive Stress f_m	All	600	750
5.	Bearing: On Full Area On 1/3 Area or less	All	376	563
		All	563	843
6.	Bar Reinforcing $F_y=40,000$ psi		0.9 F_y	0.9 F_y
7.	Continuous Wire Reinforcing $F_y=70,000$ psi		0.9 F_y	0.9 F_y

(a) Criteria used on Zion is compatible with NCMA-1974
(b) SEB Interim Criteria Rev. 1 is compatible with
ACI 531-79

H = Hollow Concrete Masonry
S = Solid Concrete Masonry
G = Grouted Concrete Masonry

IN-PLANE ANALYSIS

WALL CONSTRUCTION Hollow Block TYPE II
Jt. Reinf. 3/16" c.c.

UNCONFINED OR PARTIALLY CONFINED WALLS (STEPS 1-5)

WITHOUT VERTICAL REINFORCEMENT

WALL DESIGN PARAMETERS

$$\begin{aligned} \gamma &= 11.56 \text{ (pcf)} & \gamma &= 105 \text{ pcf} & \gamma_{\text{FILL}} &= 97 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 97 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 97 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 97 \text{ lbs./ft.} \\ \gamma_{\text{FILL}} &= 11.56 \text{ (pcf)} & \gamma_{\text{FILL}} &= 105 \text{ pcf} & \gamma_{\text{FILL}} &= 97 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 97 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 97 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 97 \text{ lbs./ft.} \\ \gamma_{\text{FILL}} &= 11.56 \text{ (pcf)} & \gamma_{\text{FILL}} &= 105 \text{ pcf} & \gamma_{\text{FILL}} &= 97 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 97 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 97 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 97 \text{ lbs./ft.} \end{aligned}$$

NET TENSION AND COMPRESSION STRESSES

$$A_v = 56.4 \text{ in}^2 / (10.2' \times 12) = 596 \text{ in}^2 \quad S_v = \frac{1}{2} (58 \times 10.2') \left(\frac{12}{12} \right) = 12,150 \text{ in}^3$$

DEF:

SEE:

$$\begin{aligned} \phi_R &= 0.12 & \text{ELEV. } 592.0' & \text{Z1 DAMPING} & \phi_R &= 0.22 & \text{ELEV. } 592.0' & \text{Z2 DAMPING} \\ \gamma_{\text{FILL}} &= 97 + 10.2' (49.6 \times 12) = 158 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 148 + 10.2' (49.6 \times 22) = 259 \text{ lbs./ft.} \\ \gamma_{\text{FILL}} &= 158 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 259 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 158 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 259 \text{ lbs./ft.} \\ \gamma_{\text{FILL}} &= 158 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 259 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 158 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 259 \text{ lbs./ft.} \end{aligned}$$

$$\begin{aligned} \gamma_{\text{FILL}} &= 158 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 259 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 158 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 259 \text{ lbs./ft.} \\ \gamma_{\text{FILL}} &= 158 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 259 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 158 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 259 \text{ lbs./ft.} \\ \gamma_{\text{FILL}} &= 158 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 259 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 158 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 259 \text{ lbs./ft.} \end{aligned}$$

$$\begin{aligned} \gamma_{\text{FILL}} &= 158 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 259 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 158 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 259 \text{ lbs./ft.} \\ \gamma_{\text{FILL}} &= 158 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 259 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 158 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 259 \text{ lbs./ft.} \\ \gamma_{\text{FILL}} &= 158 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 259 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 158 \text{ lbs./ft.} & \gamma_{\text{FILL}} &= 259 \text{ lbs./ft.} \end{aligned}$$

SARGENT & LUNDY

Client CECO

Project ZION

Proj. No. 6213-00

Equip. No. 24-0

Prepared by

Reviewed by

Approved by

Date

Date

Date

Calcs. For: WALL

Safety-Related

Calcs. No. 6213-EW

Rev.

Date

Page

of

WALL RE-EVALUATION FOR IN-PLANE LOADS

Form 00-4.3 Rev. 1

OUT-OF-PLANE ANALYSIS

WALL: A-579-9 $t = 11\frac{1}{8}$ "
CONSTRUCTION: Hollow Block, Joint Reinforcing @ 16" C.C.

SPAN: Simply Supported, 10'-2 1/8"

FREQUENCY & C-VALUES

$$f_{max} = 31.5 \times \sqrt{\frac{900}{1350}} = 25.7 \text{ cps}$$

$$f_{min} = 31.5 \times \sqrt{\frac{540}{1350}} = 19.9 \text{ cps}$$

MAXIMUM C-VALUES FOR ABOVE FREQUENCY RANGE:

ELEV. 579'-0" OBE @ 2% Damping = $0.15 \times 1.05 = 0.16$

SSE @ 2% Damping = $0.30 \times 1.05 = 0.32$

ELEV. 592'-0" OBE @ 2% Damping = $0.20 \times 1.05 = 0.21$

SSE @ 2% Damping = $0.38 \times 1.05 = 0.40$

WALL SELF LOADING

OBE: $R_{OBE} \times W = 0.21 \times 49.6 \text{ psf} = 10.4 \text{ psf}$

SSE: $R_{SSE} \times W = 0.40 \times 49.6 \text{ psf} = 20.0 \text{ psf}$

ATTACHMENT C-VALUES:

ELEV. 592'-0" $R_{OBE} = 1.0$ @ 2% Damping

$R_{SSE} = 0.96$ @ 2% Damping

WALL MOMENT & SHEAR CAPACITIES

$V_{OBE} = 1732 \text{ lb/ft}$

$V_{SSE} = 2598 \text{ lb/ft}$

$M_{OBE} = 522 \text{ ft-lb/ft}$

$M_{SSE} = 872 \text{ ft-lb/ft}$

CAPACITIES BASED ON AN EFFECTIVE WIDTH OF 1 FT.

ARGENT LUNDY

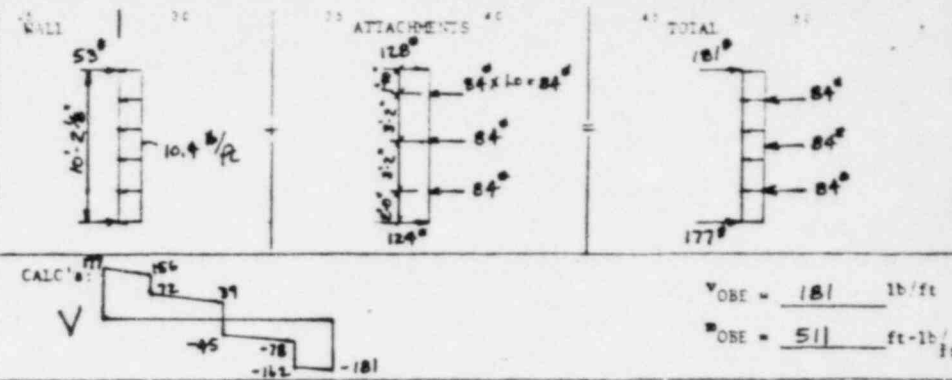
Client:	CECO
Project:	210N
File No:	6213-01
Eq. No:	EW-0

Prepared by:	Date:
Reviewed by:	Date:
Approved by:	Date:

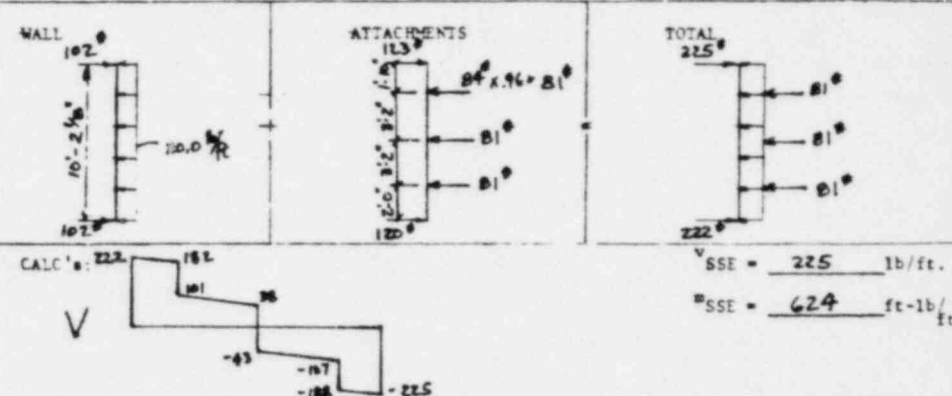
Calc. For:	WALL
X Safety-Related	Non-Safety-Related

Calc. No:	6213-EW
Rev:	Date:
Page:	of

OBE LOADING



SSE LOADING



WALL: $V_{OBE}/V_{OBE} = 181/1732 = 0.10 < 1.0$

$V_{SSE}/V_{SSE} = 225/2598 = 0.09 < 1.0$

$M_{OBE}/M_{OBE} = 511/522 = 0.98 < 1.0$

$M_{SSE}/M_{SSE} = 624/872 = 0.72 < 1.0$

SUPPORT 1: $V_{OBE}/V_{OBE} = 181/436 = 0.42 < 1.0$

$V_{SSE}/V_{SSE} = 225/727 = 0.31 < 1.0$

SUPPORT 2: $V_{OBE}/V_{OBE} = \text{SUPPORTED BY REINFORCED CONCRETE WALL} < 1.0$

$V_{SSE}/V_{SSE} = < 1.0$

CALCULATIONS FOR BLOCK WALL LOADS TABLE																			Call No. 6-21-EN			
																			Rev		Date	
																			Safety-Related		Non-Safety-Related	
																			WALL NO.			
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	
																			Date		Date	

Form 00433 Rev. 1

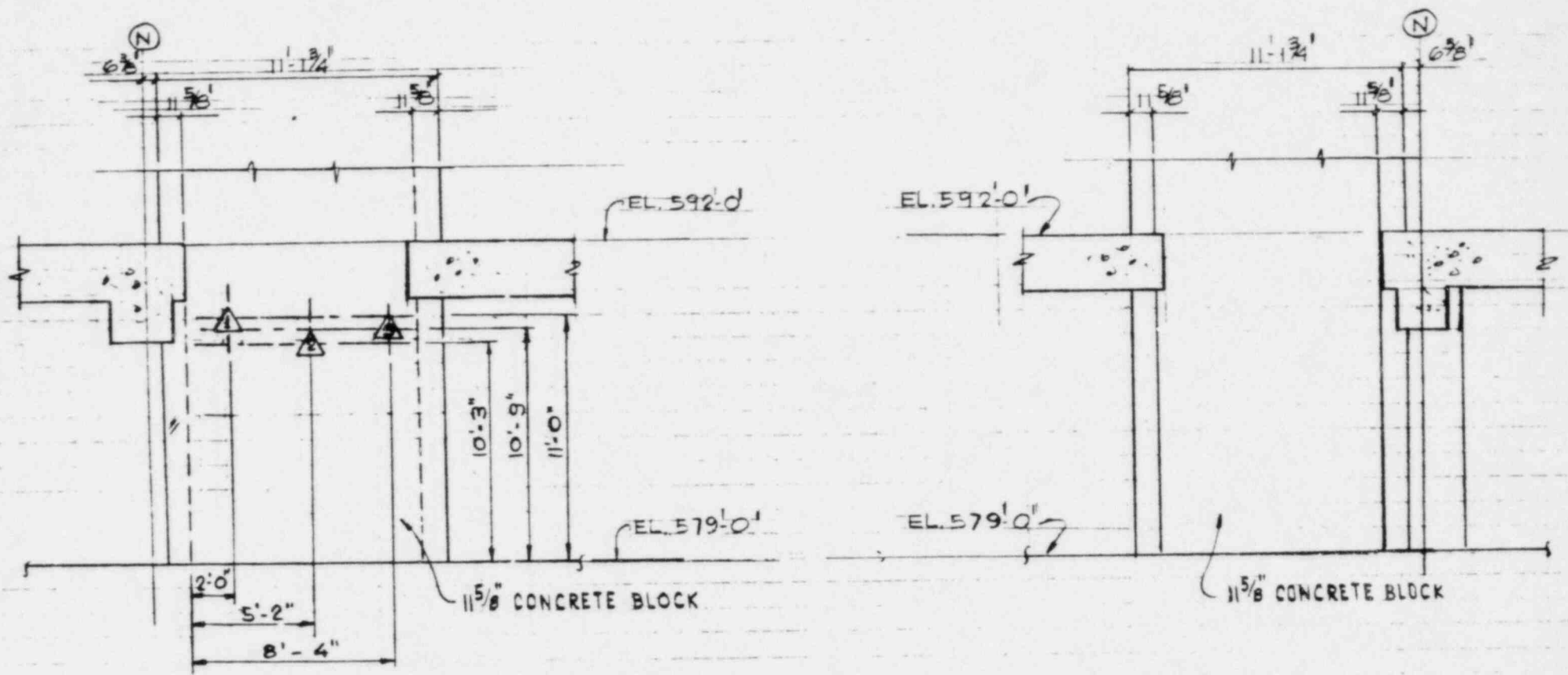
SARGENT LUNDY
INCORPORATED

Client: CECO
Project: ZION UNIT 1 & 2
Proj. No.: 6211-00 Equip. No.: 6211-0

Prepared by: _____ Date: _____
Reviewed by: _____ Date: _____
Approved by: _____ Date: _____

Calls For BLOCK WALL LOADS TABLE
WALL NO.: _____
Safety-Required: _____ Non-Safety-Required: _____

Call No.: 6211-00
Rev: _____ Date: _____
Page: _____ of _____



WALL A-579-9A SOUTH ELEV.
 SCALE: 1/4" = 1'-0"

WALL A-579-9 NORTH ELEV.
 SCALE: 1/4" = 1'-0"

EXAMPLE CALCULATION

 SARGENT & LUNDY CHICAGO	Client: <u>CECO</u>	Prepared by:	Date:	Calc. For: Safety-Related <input type="checkbox"/> Non-Safety-Related <input type="checkbox"/>	Calc. No. <u>6213-00</u>
	Project: <u>ZION STATION 1 & 2</u>	Reviewed by:	Date:		Rev. <u>1</u> Date:
	Proj. No. <u>6213-00</u> Equip. No.:	Approved by:	Date:		Page <u>1</u> of <u>1</u>